
Subject: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [Oblivion](#) on Fri, 17 Apr 2020 22:51:27 GMT
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Hello,

Blur seems to be "missing" from the image utility functions.

I've adapted Ivan Kutsir's fast blur implementation to U++.

The only missing thing is alpha channel blurring. I commented out the alpha channel blurring in the below code. (it leaves artifacts at the margins of output image)

```
Image Blur(const Image& img, int radius)
{
    // This code is adapted from Ivan Kutsir's fast blur implementation, published under MIT license.
    // See: http://blog.ivank.net/fastest-gaussian-blur.html

    // An implementation of well known fast box and gaussian blur
    // approximation algorithms by Wojciech Jarosz and Peter Kovesi.
    // See: https://elynxsdk.free.fr/ext-docs/Blur/Fast_box_blur.pdf
    // See: https://www.peterkovesi.com/papers/FastGaussianSmoothing.pdf

    auto GetBoxes = [](int sigma, int n) -> Vector<int>
    {
        double wl = ffloor(sqrt((12 * sqr(sigma) / n) + 1));
        if(fmod(wl, 2) == 0) wl--;
        double wu = wl + 2;
        double m = fround((12 * sqr(sigma) - n * sqr(wl) - 4 * n * wl - 3 * n) / (-4 * wl - 4));
        Vector<int> sizes;
        for (int i = 0; i < n; i++)
            sizes.Add(i < m ? wl : wu);
        return pick(sizes);
    };

    auto ApplyBoxBlur = [] (const Image& src, int r) -> Image
    {
        double avg = 1.0 / (r + r + 1);

        Size sz = src.GetSize();
        ImageBuffer tmp(sz);
        ImageBuffer out(sz);

        Premultiply(tmp);
        Premultiply(out);
```

```

for(int i = 0; i < sz.cy; i++) {
    int ti = 0;
    int li = ti;
    int ri = r;
    const RGBA& fv = src[i][0];
    const RGBA& lv = src[i][sz.cx - 1];
    dword rsum = fv.r * (r + 1);
    dword gsum = fv.g * (r + 1);
    dword bsum = fv.b * (r + 1);
    // dword asum = fv.a * (r + 1);
    for(int j = 0; j < r; j++) {
        const RGBA& p = src[i][j];
        rsum += p.r;
        gsum += p.g;
        bsum += p.b;
        // asum += p.a;
    }
    for(int j = 0; j <= r; j++) {
        const RGBA& p = src[i][ri++];
        RGBA& q = tmp[i][ti++];
        q.r = (rsum += p.r - fv.r) * avg;
        q.g = (gsum += p.g - fv.g) * avg;
        q.b = (bsum += p.b - fv.b) * avg;
        // q.a = (asum += p.a - fv.a) * avg;
    }
    for(int j = r + 1; j < sz.cx - r; j++) {
        const RGBA& p = src[i][ri++];
        const RGBA& q = src[i][li++];
        RGBA& t = tmp[i][ti++];
        t.r = (rsum += p.r - q.r) * avg;
        t.g = (gsum += p.g - q.g) * avg;
        t.b = (bsum += p.b - q.b) * avg;
        // t.a = (asum += p.a - q.a) * avg;
    }
    for(int j = sz.cx - r; j < sz.cx ; j++) {
        const RGBA& p = src[i][li++];
        RGBA& q = tmp[i][ti++];
        q.r = (rsum += lv.r - p.r) * avg;
        q.g = (gsum += lv.g - p.g) * avg;
        q.b = (bsum += lv.b - p.b) * avg;
        // q.a = (bsum += lv.a - p.a) * avg;
    }
}

for(int i = 0; i < sz.cx; i++) {
    int ti = 0;
    int li = ti;
    int ri = r;

```

```

const RGBA& fv = tmp[ti][i];
const RGBA& lv = tmp[sz.cy - 1][i];
dword rsum = fv.r * (r + 1);
dword gsum = fv.g * (r + 1);
dword bsum = fv.b * (r + 1);
// dword asum = fv.a * (r + 1);
for(int j = 0; j < r; j++) {
    const RGBA& p = tmp[j][i];
    rsum += p.r;
    gsum += p.g;
    bsum += p.b;
    // asum += p.a;
}
for(int j = 0; j <= r; j++) {
    const RGBA& p = tmp[ri++][i];
    RGBA& q = out[ti++][i];
    q.r = (rsum += p.r - fv.r) * avg;
    q.g = (gsum += p.g - fv.g) * avg;
    q.b = (bsum += p.b - fv.b) * avg;
    // q.a = (asum += p.a - fv.a) * avg;
}
for(int j = r + 1; j < sz.cy - r; j++) {
    const RGBA& p = tmp[ri++][i];
    const RGBA& q = tmp[li++][i];
    RGBA& t = out[ti++][i];
    t.r = (rsum += p.r - q.r) * avg;
    t.g = (gsum += p.g - q.g) * avg;
    t.b = (bsum += p.b - q.b) * avg;
    // t.a = (asum += p.a - q.a) * avg;
}
for(int j = sz.cy - r; j < sz.cy; j++) {
    const RGBA& p = tmp[li++][i];
    RGBA& q = out[ti++][i];
    q.r = (rsum += lv.r - p.r) * avg;
    q.g = (gsum += lv.g - p.g) * avg;
    q.b = (bsum += lv.b - p.b) * avg;
    // q.a = (asum += lv.a - p.a) * avg;
}
}

out.SetHotSpots(src);
out.SetResolution(src.GetResolution());
return out;
};

if(radius < 1 || IsNull(img))
    return img;

```

```
Vector<int> boxes = GetBoxes(radius, 3);

Image pass1 = ApplyBoxBlur(img, (boxes[0] - 1) / 2);
Image pass2 = ApplyBoxBlur(pass1, (boxes[1] - 1) / 2);
Image output = ApplyBoxBlur(pass2, (boxes[2] - 1) / 2);

return pick(output);
}
```

If you think that it needs more refining, let me know, or feel free to modify it as it suits your needs.

Note: It should be easy to add a MT variant, using CoDo if needed.

Best regards,
Oblivion

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [mirek](#) on Sat, 18 Apr 2020 17:33:20 GMT
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Thanks. I am not quite sure what you have meant by those

```
Premultiply(tmp);
Premultiply(out);
```

At that point, these are empty, right?

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [Oblivion](#) on Sat, 18 Apr 2020 18:15:04 GMT
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Ah, yes, I totally forgot that! :roll:

AFAIK, a single Premultiply(out) at the end should be sufficient.

Edit: But since this implementation don't have a working alpha channel, Premultiply should be removed completely.

This algorithm is not "the fastest", but reasonably fast and works well.

Best regards,
Oblivion

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [mirek](#) on Sat, 18 Apr 2020 21:43:35 GMT
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Oblivion wrote on Sat, 18 April 2020 20:15Ah, yes, I totally forgot that! :roll:

AFAIK, a single Premultiply(out) at the end should be sufficient.

Edit: But since this implementation don't have a working alpha channel, Premultiply should be removed completely.

This algorithm is not "the fastest", but reasonably fast and works well.

Best regards,
Oblivion

Ah, but then it should probably start with "unmultiply"...

Mirek

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [Oblivion](#) on Sun, 19 Apr 2020 08:13:35 GMT
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Hello Mirek,

The problem wasn't in the blur code after all.

It turned out that background of the image viewer I wrote to test the code wasn't correctly initialized/cleaned/painted.

So the images with premultiplied alpha channel were interacting with the "unclean" background, resulting in artifacts

Not to mention I accidentally added a blue channel's sum to the alpha channel in the first code (It was an exhausting week, sorry. :?)

Now I can confirm that below code works for images with premultiplied alpha channel.

```
Image Blur(const Image& img, int radius)
{
```

```
// This code is adapted from Ivan Kutsir's fast blur implementation, published under MIT license.
// See: http://blog.ivank.net/fastest-gaussian-blur.html

// An implementation of well known fast box and gaussian blur
// approximation algorithms by Wojciech Jarosz and Peter Kovesi.
// See: https://elynxsdk.free.fr/ext-docs/Blur/Fast\_box\_blur.pdf
// See: https://www.peterkovesi.com/papers/FastGaussianSmoothing.pdf
```

```
auto GetBoxes = [](int sigma, int n) -> Vector<int>
{
    double wl = ffloor(sqrt((12 * sqr(sigma) / n) + 1));
    if(fmod(wl, 2) == 0) wl--;
    double wu = wl + 2;
    double m = fround((12 * sqr(sigma) - n * sqr(wl) - 4 * n * wl - 3 * n) / (-4 * wl - 4));
    Vector<int> sizes;
    for (int i = 0; i < n; i++)
        sizes.Add(i < m ? wl : wu);
    return pick(sizes);
};

auto ApplyBoxBlur = [] (const Image& src, int r) -> Image
{
    double avg = 1.0 / (r + r + 1);

    Size sz = src.GetSize();

    ImageBuffer tmp(sz);
    ImageBuffer out(sz);

    for(int i = 0; i < sz.cy; i++) {
        int ti = 0;
        int li = ti;
        int ri = r;
        const RGBA& fv = src[i][0];
        const RGBA& lv = src[i][sz.cx - 1];
        dword rsum = fv.r * (r + 1);
        dword gsum = fv.g * (r + 1);
        dword bsum = fv.b * (r + 1);
        dword asum = fv.a * (r + 1);
        for(int j = 0; j < r; j++) {
            const RGBA& p = src[i][j];
            rsum += p.r;
            gsum += p.g;
            bsum += p.b;
            asum += p.a;
        }
        for(int j = 0; j <= r; j++) {
            const RGBA& p = src[i][ri++];
```

```

    RGBA& q      = tmp[i][ti++];
    q.r = (rsum += p.r - fv.r) * avg;
    q.g = (gsum += p.g - fv.g) * avg;
    q.b = (bsum += p.b - fv.b) * avg;
    q.a = (asum += p.a - fv.a) * avg;
}
for(int j = r + 1; j < sz.cx - r; j++) {
    const RGBA& p = src[i][ri++];
    const RGBA& q = src[i][li++];
    RGBA& t      = tmp[i][ti++];
    t.r = (rsum += p.r - q.r) * avg;
    t.g = (gsum += p.g - q.g) * avg;
    t.b = (bsum += p.b - q.b) * avg;
    t.a = (asum += p.a - q.a) * avg;
}
for(int j = sz.cx - r; j < sz.cx ; j++) {
    const RGBA& p = src[i][li++];
    RGBA& q      = tmp[i][ti++];
    q.r = (rsum += lv.r - p.r) * avg;
    q.g = (gsum += lv.g - p.g) * avg;
    q.b = (bsum += lv.b - p.b) * avg;
    q.a = (asum += lv.a - p.a) * avg;
}
}

for(int i = 0; i < sz.cx; i++) {
    int ti = 0;
    int li = ti;
    int ri = r;
    const RGBA& fv = tmp[ti][i];
    const RGBA& lv = tmp[sz.cy - 1][i];
    dword rsum = fv.r * (r + 1);
    dword gsum = fv.g * (r + 1);
    dword bsum = fv.b * (r + 1);
    dword asum = fv.a * (r + 1);
    for(int j = 0; j < r; j++) {
        const RGBA& p = tmp[j][i];
        rsum += p.r;
        gsum += p.g;
        bsum += p.b;
        asum += p.a;
    }
    for(int j = 0; j <= r; j++) {
        const RGBA& p = tmp[ri++][i];
        RGBA& q      = out[ti++][i];
        q.r = (rsum += p.r - fv.r) * avg;
        q.g = (gsum += p.g - fv.g) * avg;
        q.b = (bsum += p.b - fv.b) * avg;
    }
}

```

```

    q.a = (asum += p.a - fv.a) * avg;
}
for(int j = r + 1; j < sz.cy - r; j++) {
    const RGBA& p = tmp[ri++][i];
    const RGBA& q = tmp[li++][i];
    RGBA& t = out[ti++][i];
    t.r = (rsum += p.r - q.r) * avg;
    t.g = (gsum += p.g - q.g) * avg;
    t.b = (bsum += p.b - q.b) * avg;
    t.a = (asum += p.a - q.a) * avg;
}
for(int j = sz.cy - r; j < sz.cy; j++) {
    const RGBA& p = tmp[li++][i];
    RGBA& q = out[ti++][i];
    q.r = (rsum += lv.r - p.r) * avg;
    q.g = (gsum += lv.g - p.g) * avg;
    q.b = (bsum += lv.b - p.b) * avg;
    q.a = (asum += lv.a - p.a) * avg;
}
}

out.SetHotSpots(src);
out.SetResolution(src.GetResolution());
return out;
};

if(radius < 1 || IsNull(img))
    return img;

Vector<int> boxes = GetBoxes(radius, 3);

Image pass1 = ApplyBoxBlur(img, (boxes[0] - 1) / 2);
Image pass2 = ApplyBoxBlur(pass1, (boxes[1] - 1) / 2);
Image output = ApplyBoxBlur(pass2, (boxes[2] - 1) / 2);

return pick(output);
}

```

Best regards,
Oblivion

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
 Posted by [mirek](#) on Sun, 19 Apr 2020 15:09:23 GMT

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In the end, I have renamed to GaussianBlur and done some code simplification. Also added "co" parameter for parallel processing, although it does not show much performance gains (less than 70% speedup on 2700x).

Using upptst/Blur for testing this...

Mirek

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [Oblivion](#) on Sun, 19 Apr 2020 16:06:23 GMT

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Hello Mirek,

Quote:In the end, I have renamed to GaussianBlur and done some code simplification. Also added "co" parameter for parallel processing, although it does not show much performance gains (less than 70% speedup on 2700x).

Thanks!

I've used the upptst/blur code and the supplied image, and other images that I have, on one of my machines with AMD FX6100, six-core processor, and I got ~3x (2.74) speedup (consistently). While not spectacular, it is nice and noticeable. :)

I'll test it further...

By the way, that CoFor looks like a really handy addition.

Best regards,
Oblivion

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [mirek](#) on Mon, 20 Apr 2020 10:30:10 GMT

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Yeah, I have realized that it is probably related to false cache sharing and tried to fix that (I think that is the comment you are seeing), which brings it to about 2x faster on 2700x.

Maybe finetuning block size would improve it further...

Subject: Re: [Proposal] Blur algorithm (fast box blur with gaussian approximation)
Posted by [Oblivion](#) on Tue, 21 Apr 2020 11:04:44 GMT
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Yep, the latest optimization definitely added some speed. Average on same hardware and with same images is now 3.42.

By the way, the "Vector<int> sizes" is left unused in the code, at ln: 1095.

Best regards,
Oblivion
